Carex orestera (Cyperaceae), a New Sedge from the Mountains of California

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ABSTRACT. *Carex orestera* Zika (Cyperaceae) is described from western North America and is endemic to five counties in central and southern California in the Sierra Nevada range and the adjacent White Mountains. The taxon is separable from *C. albonigra* Mack. in its more lanceolate to oblong scales with a conspicuous pale midvein and relatively narrower perigynia. The new species is assigned to *Carex* L. sect. *Racemosae* G. Don, and a sectional key is provided for these sedges in California.

Key words: California, *Carex*, Cyperaceae, IUCN Red List.

Carex L. sect. *Racemosae* G. Don (Cyperaceae) is a northern hemisphere group of ca. 60 species with 11 indigenous species reported from California (Murray, 2002). One widespread member of the section is *C. albonigra* Mack., with a range from Alaska to Arizona in western North America. Specimens called *C. albonigra* from California have puzzled caricologists, because the specimens do not agree with typical Rocky Mountain plants (Murray, 1969, 2002; Wilson et al., 2008; Taylor, 2011; Zika et al., 2012). The Californian populations are described here as a novelty. The new sedge was first collected in 1930 by F. W. Peirson.

Carex orestera Zika, sp. nov. TYPE: U.S.A. California: Mono Co., subalpine talus, above NW end of Gardisky Lake, 3250 m, 11 Aug. 2010, *P. F. Zika 25338 & S. Matson* (holotype, WTU; isotypes, CAN, CAS, CHSC, GH, JEPS, MICH, MO, NY, OSC, RSA, US). Figures 1, 2A, C.

Haec species a *Carice albonigra* Mack. squamis femineis oblongis costa pallida conspicua atque perigyniis pro ratione angustioribus differt.

Plants perennial, densely to loosely caespitose; rhizomes short or slightly elongated, 1–30 × 1.5–2.5 mm, clothed in light brown to mid brown scales, sometimes slightly fibrous; fertile stems (culms) sharply triangular, scabrous distally, longer than leaves, 3.5–39 cm tall, papillose at 20×, phyllopodic, 4 to 10 stem leaves on lower third of stem, rarely 1 bractlike leaf with blade 1–9.5 cm arising from midstem; sterile leafy shoots in rosettes, with 1 or 2 bladeless scalelike basal leaves. Stem bases light brown, sometimes suffused with red-purple. Leaves blue-green, glabrous, papillose adaxially and abaxially, blades folded in V- or W-shape when fresh, sometimes flattening with age, abaxial surface with midvein more pronounced than lateral veins, margins scabrous, blades 20–110 × 1.3–3.5 mm; sheath faces smooth, white to translucent or pale brown, truncate or shallowly notched, not fibrillose, often overlapping and obscured. Inflorescences dark purple, erect, 14–60 × 4–12 mm; 2 to 4(5) ascending spikes, in elliptic to ovate (rarely oblong) cluster, rarely basal spikes separated 15–33 mm; inflorescence bract green or more usually dark purple with green midvein, sheath 0–4 mm, blade green or purple and green, 0–65 mm; basal spike subsessile, rarely on erect peduncle 3–21 mm; lateral spikes pistillate, narrowly oblong to lance-oblong, 4–12(–19) × 2.5–5 mm; terminal spike 7–20 × 4–8.5 mm, mostly mixed sex, perigynia usually terminal and spike ♀/♂ (gynecandrous) or ♀/♂/♀, rarely ♀/♂, ♂/♀ (androgynous), or ♂, staminate portion of spike usually less than 70% of length; scales from lower half of lateral pistillate spikes usually lanceolate to oblong or elliptic, narrowly ovate, sometimes narrowly elliptic, elliptic-ovate, or ovate, dark purple, smooth or papillose to scabrous distally, midvein usually pale and conspicuous, 2.7–3.7 mm, margins with narrow hyaline zone 0.05–0.5 mm wide, hyaline margin broadest on staminate scales, base clasping rachis, apex blunt, acute, or acuminate, sometimes with mucro 0.1–0.3 mm, scabrous or not. Perigynia mostly oblanceolate to narrowly elliptic, less common variants are elliptic to obovate or broadly elliptic, trigonous or somewhat flattened but bulging over achene, dark purple or largely so on a green background, the green aging to golden brown, not scabrous, papillose at 20×, 2.4–3.6 × 0.9–1.4(–1.6) mm, faces nerveless or 1 to 3 faint adaxial nerves, 1 to 6 faint abaxial nerves, base

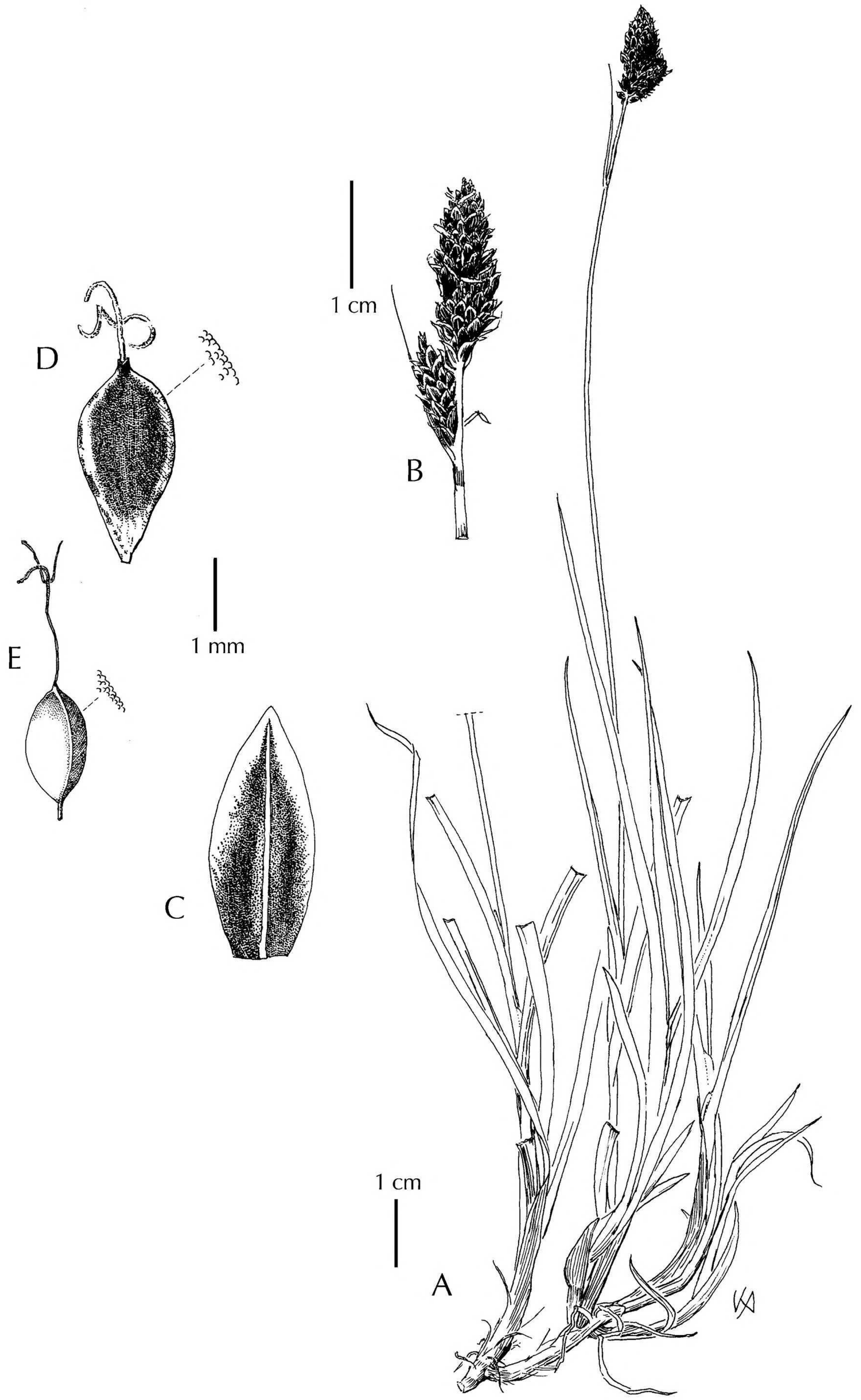

Figure 1. *Carex orestera* Zika. —A. Habit. —B. Inflorescence. —C. Pistillate scale. —D. Perigynium, showing papillose surface in magnification at right. —E. Achene, showing stipe and papillose surface. A–E were taken from the holotype *P. F. Zika 25338 & S. Matson* (WTU).

acute to acuminate, apex abruptly tapered to distinct beak 0.2–0.3 mm; beak teeth acute, 0.1–0.15 mm, dark purple, white-tipped, inconspicuous; anthers 2.2–3.5 × 0.3–0.4 mm when dehisced, including terminal awn 0.1–0.2 mm; stigmas 3, plumose, exserted. Achenes mid brown, trigonous-elliptic, surface granular at 20×, body 1.2–1.6 × 0.7–0.95 mm, not including stipe or style, stipe (0–)0.2–0.4

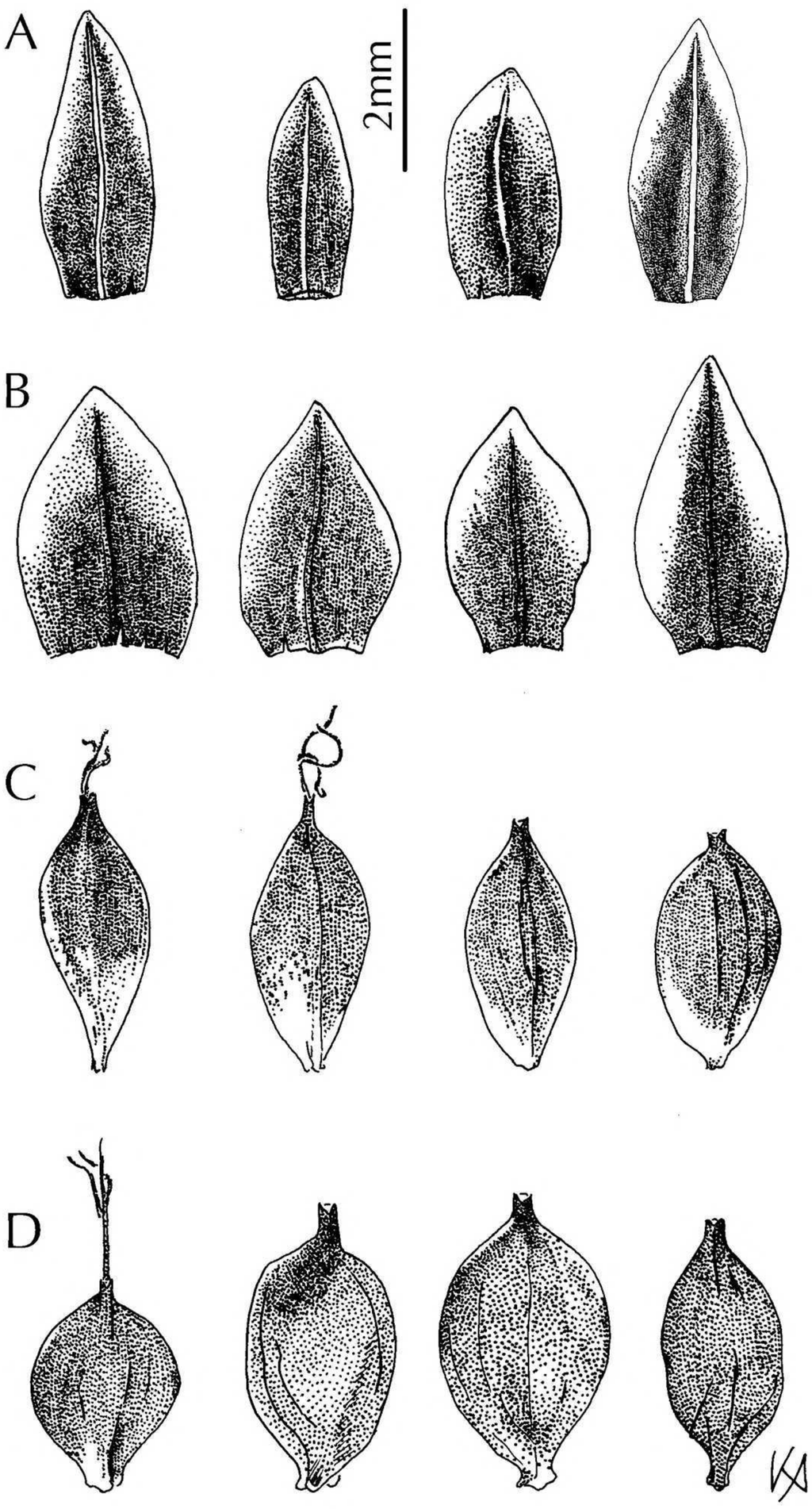

Figure 2. A, B. Pistillate scales from proximal half of spike. —A. *Carex orestera* Zika (left to right, from *P. F. Zika 25359*, three from *P. F. Zika 25338 & S. Matson* [type], all WTU). —B. *C. albonigra* Mack. (left to right, two from *D. T. Macdougal 408*, *P. F. Scholander S-186*, *W. Flagg, J. Barrell & S. Spongberg 116–66*, all US). C, D. Mature perigynia from lower third of spike. —C. *C. orestera* (left to right, two from *P. F. Zika 25359*, two from *P. F. Zika 25338*, all WTU). —D. *C. albonigra* (left to right, from *Barrell 116–66*, two from *Macdougal 408*, *Scholander S-186*, all US).

mm, style remnant 0.05–0.9 mm; achenes filling more than half the perigynium.

Distribution and habitat. *Carex orestera* is restricted to five counties in the central and southern high Sierra Nevada and White Mountains ecoregions of California in the United States (Hickman, 1993; Fig. 3). Habitats are near treeline and include dry to mesic rocky slopes, boulder fields, the shores of meltwater pools and streamlets and are always in full sun from elevations of 3000 to 4130 m (Lloyd & Mitchell, 1973). Most populations are found on granodiorite, but there are collections from sedimentary bedrock (limestone and sandstone), volcanics (including felsic flows and tephrite), and metamorphics (hornfels) that are occasionally somewhat limy (Consortium of California Herbaria, 2011).

Common or characteristic associates include: *Botrychium simplex* E. Hitchc. (Ophioglossaceae), *Calamagrostis muiriana* B. L. Wilson & Sami Gray (Poaceae), *Carex breweri* Boott (Cyperaceae), *C. filifolia* Nutt. var. *erostrata* Kük., *C. fissuricola* Mack., *C. helleri* Mack., *C. nigricans* C. A. Mey., *C. phaeocephala* Piper, *C. rossii* Boott, *C. spectabilis* Dewey, *C. subnigricans* Stacey, *C. vernacula* L. H. Bailey, *Deschampsia cespitosa* (L.) P. Beauv. (Poaceae), *Ivesia lycopodioides* A. Gray (Rosaceae), *Juncus drummondii* E. Mey. (Juncaceae), *Lupinus lepidus* Douglas ex Lindl. (Fabaceae), *Luzula orestera* Sharsm. (Juncaceae), *L. spicata* (L.) DC., *Oxyria digyna* (L.) Hill (Polygonaceae), *Pedicularis attollens* A. Gray (Orobanchaceae), *Phlox diffusa* Benth. (Polemoniaceae), *Pinus albicaulis* Engelm. (Pinaceae), *Podistera nevadensis* (A. Gray) S. Watson (Apiaceae), *Potentilla bruceae* Rydb. (Rosaceae), *P. drummondii* Lehm., *P. fruticosa* L., *Salix eastwoodiae* Cockerell ex A. Heller (Salicaceae), *S. petrophila* Rydb., *Solidago multiradiata* Aiton (Asteraceae), and *Trisetum spicatum* (L.) K. Richt. (Poaceae).

IUCN Red List category and conservation concerns. *Carex orestera* has a small global range, measuring roughly 170 × 80 km (Fig. 3). Verified herbarium records document a total of 41 known populations. Inventories of population size and stability are needed. Colonies I have visited are usually small, with fewer than 50 genets. Although their high elevation habitats seem remote from most human disturbance, exotic seed-eating animals, like white-tailed ptarmigan (*Lagopus leucurus* Richardson, introduced to California in 1971; Frederick & Gutiérrez, 1992), and climate change may represent long-term threats. By IUCN (2001) criteria, this taxon is assessed as Least Concern (LC).

Phenology. Ripe perigynia are found from mid-July to the first week of September, but many July collections are immature.

Etymology. The Greek epithet *orestera* refers to its mountain habitat, as does the vernacular name boulder sedge.

Discussion. Morphologically, *Carex orestera* appears to be most closely related to *C. albonigra*. Both are in *Carex* sect. *Racemosae* and found in similar habitats. The taxa share a loosely to densely

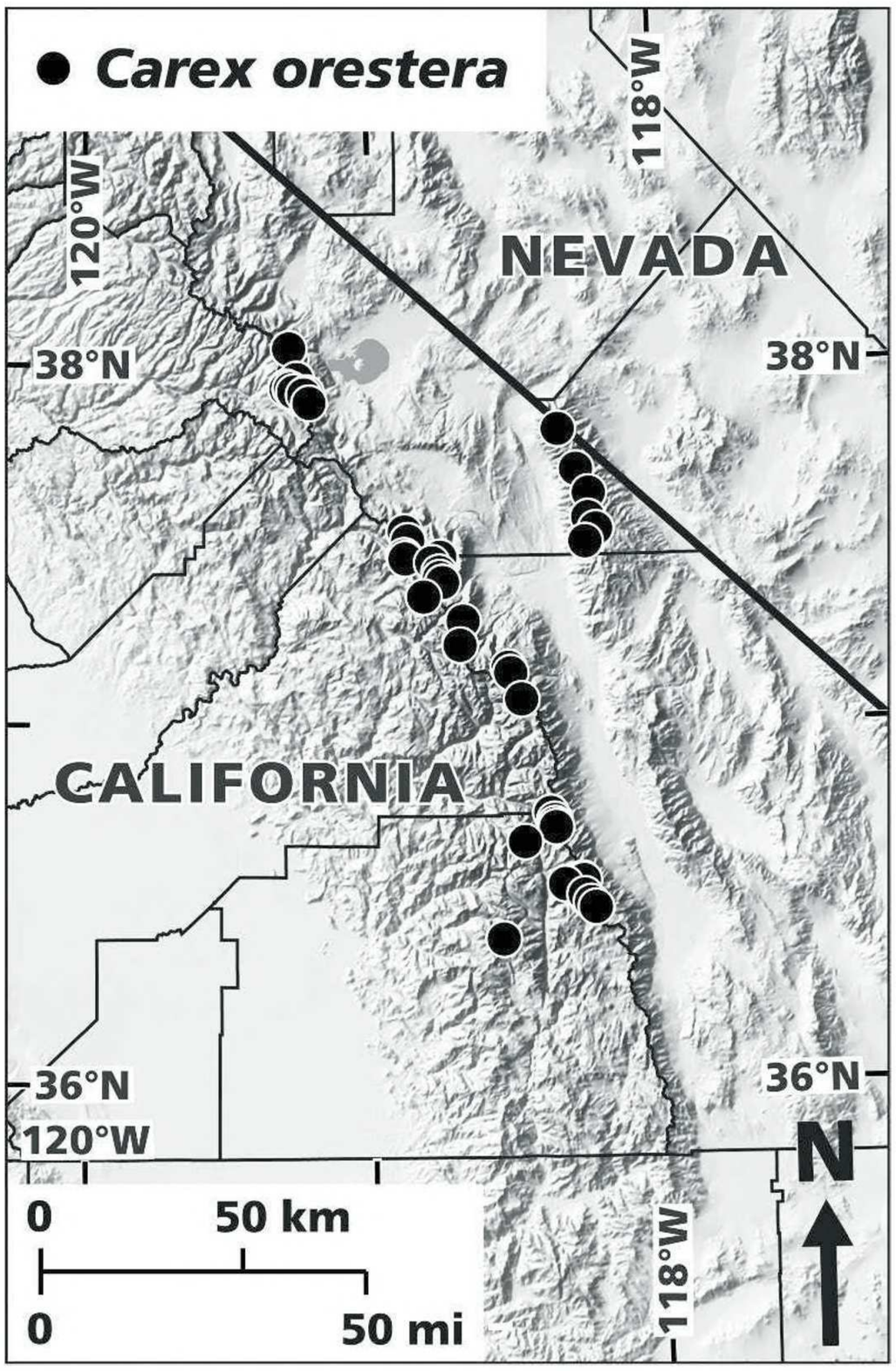

Figure 3. Distribution map of *Carex orestera* Zika, based on voucher specimens at the herbaria cited in the acknowledgments.

caespitose habit, dark and small, erect inflorescences with overlapping spikes, essentially gynecandrous terminal spikes, and dark purple scales. In addition, at 20× magnification, they share papillose perigynia, foliage, and stems, and sometimes the scales are papillose as well, demarcating them both from *C. heteroneura* W. Boott, which has essentially no papillae on the perigynia, scales, and stems, and often grows at elevations below 3000 m. The similar *C. helleri* is found near treeline growing with *C. orestera*, but *C. helleri* has essentially no papillae on the perigynia, has occasional papillae on some scale midveins, and differs in the lower pistillate scales with their distinctive awns, often more than 0.5 mm. The corresponding scale tips of *C. orestera* are unawned, or sometimes bear a short mucro up to 0.3 mm. In the field, *C. helleri* usually looks quite different with larger, wider spikes in a broader and denser headlike cluster.

Table 1 shows a comparison of critical characters for *Carex orestera* and *C. albonigra*. The base of the stem is often different. Carefully made collections of *C. albonigra*, showing the basal scales on fertile stems and new shoots, are usually purple, and at 10× show no more than a few fibers as the scales age. In contrast, roughly a third of the collections of *C. orestera* are purple at the base, while the rest are brown. *Carex orestera* stem bases can be slightly or moderately fibrous. In the inflorescence, *C. albonigra* typically has dark purple scales with an inconspicuous dark midvein, while *C. orestera* has a prominently contrasting pale or whitish midvein. Mature scale shape (when perigynia are mature) can be useful in *Carex* sect. *Racemosae*, although many species are curved and slightly clasping at the base, making it difficult to see their outline even with dissection from the spike. Extensive samples of species of this section tend to show much more variation in scale and perigynium shape than usually credited in floras and is one reason that existing identification keys can be challenging. Both *C. albonigra* and *C. orestera* are found near timberline and tolerate a broad range of soil moisture, bedrock, snow cover, and wind. Some of their variation in scale and perigynium shape may be a phenotypic response

Table 1. Morphological comparison of *Carex albonigra* and *C. orestera*. Scales and perigynia are taken from the lower half of pistillate, lateral spikes.

Character	*C. albonigra*	*C. orestera*
Common ♀ scale shape	broadly elliptic to broadly ovate, elliptic-ovate, oblong-ovate	lanceolate to oblong or elliptic, narrowly ovate
Uncommon ♀ scale shape	elliptic-oblong, oblong, elliptic, ovate	narrowly elliptic, elliptic-ovate, ovate
♀ scale midvein	usually dark, not contrasting with scale body	usually pale, strongly contrasting with scale body
Common perigynium shape	broadly elliptic to broadly obovate, obovate, broadly ovate	oblanceolate to narrowly elliptic
Uncommon perigynium shape	elliptic	elliptic to obovate, broadly elliptic
Perigynium length (mm)	2.3–3.7	2.4–3.6
Perigynium width (mm)	(1.1–)1.4–2.3(–2.5)	0.9–1.4(–1.6)
Achene base	sessile or essentially so	stipe 0.2–0.4 mm, sometimes sessile
Stem base	usually purple, faintly fibrous	brown or purple, faintly or moderately fibrous

to gradients in moisture and exposure. Murray (1969) noted that scales from the distal fourth of the spike should not be regarded as typical in *Carex* sect. *Racemosae*. Similarly, the distal perigynia, as in many *Carex*, also tend to be atypically narrow. *Carex albonigra* scales are usually broadly elliptic to broadly ovate on the lower half of the lateral spikes with variations (Table 1, Fig. 2B). The corresponding scales of *C. orestera* are usually relatively narrower and more lanceolate to oblong with variations (Table 1, Fig. 2A). The perigynia of *C. albonigra* are often more than 1.6 mm wide, and thus can be wider than *C. orestera* (Table 1). However, poorly developed or bent perigynia of *C. albonigra* can be as narrow as the widest *C. orestera* perigynia, and in these cases, shape helps distinguish them. *Carex orestera* perigynia tend to be oblanceolate to narrowly elliptic (Fig. 2C), while *C. albonigra* perigynia are typically broadly elliptic to broadly obovate, with variations (Fig. 2D). Exceptional perigynia can be confusing (see perigynia at far right in Fig. 2C, D), but the majority show the characteristic shapes described in Table 1. Finally, the two species are allopatric. *Carex albonigra* is essentially a plant of the Rocky Mountains, approaching California no closer than the San Francisco Mountains of Coconino County, Arizona, 600 km to the east of the White Mountains. *Carex albonigra* illustrations in Mackenzie (1940), Cronquist (1969, 1977), and Murray (2002) were based on specimens of *C. albonigra*, not *C. orestera*.

Key to taxa. A key is provided for all members of *Carex* sect. *Racemosae* in California. Fully mature perigynia with ripe achenes are required as well as basal parts of the plant. Pistillate scale shape is often useful, but scales from the upper fourth of a spike are often narrower than typical and should not be used (Murray, 1969). Terminal spikes are typically ♀/♂ (gynecandrous) in the section, but can vary, even on one plant, to ♂/♀ (androgynous), or ♀/♂/♀. *Carex heteroneura* uncommonly has some stems on a clump with entirely staminate terminal spikes, including the holotype at GH (Murray, 2002). From viewing such plants in the field, I have found an adequate sample of *C. heteroneura* will show many "typical" gynecandrous terminal spikes.

Two species reported by Murray (2002) from California are not included in the key below. The first is *Carex bella* L. H. Bailey, based on a 16 July 1959 gathering from Mariposa County, Yosemite National Park, three miles northeast of Chinquapin, Glacier Point Road, 7000 ft. (*L. S. Rose 59143*, CAS, WTU). After examining plants at this location, and Rose's herbarium vouchers, I believe the plants are merely a robust form of *C. heteroneura*, which occasionally has elongate spikes and somewhat drooping peduncles and thus can resemble *C. bella*. However, the California plants have lateral spikes entirely pistillate, and the pistillate scales do not strongly clasp the perigynia. *Carex bella* specimens from Arizona and further east have diagnostic strongly clasping scale bases wrapped around the lower third of the perigynia and usually have gynecandrous lateral spikes with a few proximal staminate flowers. A second species of *Carex* sect. *Racemosae* noted for California is *C. epapillosa* Mack. (Mastrogiuseppe, 1993; Murray, 2002). It is not in the key, because I could not find consistent differences between it and *C. heteroneura* when examining the morphological variation of the complex from California to Wyoming. Intermediate specimens are common, as are collections that combine various features of both taxa, especially in California and Oregon. The most recent California flora considers *C. epapillosa* synonymous under the earlier name *C. heteroneura* (Zika et al., 2012).

KEY TO SPECIES INCLUDED IN *CAREX* SECT. *RACEMOSAE* IN CALIFORNIA

1. Proximal pistillate scales long-awned to acuminate, awns usually 0.5–2 mm or longer 2
2. Plants caespitose; perigynia smooth at 20×; proximal leaf sheaths not fibrous; dry slopes near or above treeline ..... *C. helleri*
2′. Plants rhizomatous; perigynia papillose at 20×; proximal leaf sheaths ladder-fibrillose; shores, wet meadows, and peatlands below treeline ..... *C. buxbaumii* Wahlenb.
1′. Proximal pistillate scales acute to acuminate, sometimes with a short mucronate apex or short awns < 0.5 mm 3
3. Perigynium surface smooth, not papillose at 20× (occasionally faintly papillose at 40×) 4
4. Mature lateral spikes ♀/♂ (gynecandrous), proximal scales subtending filaments from ♂ flowers ..... *C. mertensii* J. D. Prescott ex. Bong.
4′. Mature lateral spikes ♀ (pistillate), proximal scales subtending perigynia 5
5. Terminal spikes always ♂ (staminate); perigynia slightly inflated ..... *C. raynoldsii* Dewey
5′. Terminal spikes usually ♀/♂ (gynecandrous, rarely ♂ on some stems; other stems always ♀/♂); perigynia flattened over achenes, not inflated ..... *C. heteroneura*
3′. Perigynium surface papillose at 20× 6
6. Terminal spikes, or some of them, ♂/♀ (androgynous) or completely ♂ (staminate) 7
7. Plants rhizomatous to loosely caespitose; perigynia 2–3 mm; spikes 3–5 mm wide; meadows 2800–3400 m, over dolomite ..... *C. idahoa* L. H. Bailey
7′. Plants caespitose; perigynia usually 3–5 mm; spikes 6–11 mm wide; damp slopes below 1800 m, often over serpentine .... *C. serratodens* W. Boott
6′. Terminal spikes usually ♀/♂ (gynecandrous) 8
8. Perigynia mostly ovate ..... *C. serratodens*
8′. Perigynia elliptic to obovate or oblanceolate 9

9. Perigynia green to olive-green, ripening to an iridescent golden, conspicuous and strongly contrasting with the much shorter and darker scales; scale midvein dark and inconspicuous against dark scale body ... *C. stevenii* (Holm) Kalela
9′. Perigynia dark purple or dark brown (rarely yellow), inconspicuous against scales or hidden by them; scale midvein usually pale and conspicuous against dark scale body 10
10. Perigynium upper body and beak scabrous-bristly, on at least some perigynia; pistillate scales broadly elliptic to obovate in proximal half of spike; scale tips or awns sometimes bristly; plants rhizomatous to loosely caespitose ... *C. idahoa*
10′. Perigynium upper body and beak not scabrous-bristly; pistillate scales usually lanceolate to oblong or elliptic, sometimes narrowly ovate in proximal half of spike; scale tips or awns not bristly; plants caespitose to loosely so ... *C. orestera*

Paratypes. U.S.A. **California:** Fresno Co., S of Mount Muriel, 3718 m, 23 July 1952, *P. H. Raven 4666* (CAS); Palisades N of Palisade Lakes, 3535 m, 17 July 1956, *P. H. Raven 9747* (CAS); Lake Italy, 3393 m, 3 Aug. 1954, *P. H. Raven 7758* (CAS); second rocky canyon step above Mott Lake, 3108 m, 30 Aug. 1952, *C. H. Quibell & E. Quibell 1534* (CAS); Fourth Recess, 3078 m, 19 July 1946, *J. T. Howell 22527* (CAS, US); Inyo Co., Mt. Whitney, Consultation Lake, 3590 m, 19 July 1954, *P. H. Raven & G. T. Robbins 7478* (CAS); head of Lone Pine Canyon, [mixed w/ *Carex subnigricans*], 3658 m, 22 Aug. 1937, *C. W. Sharsmith 3371* (CAS, UC, US); Inconsolable Range above Thunder & Lightning Lake, 3658 m, 14 Aug. 1947, *J. T. Howell 24105* (CAS); W of Sixth Lake, Big Pine Lakes, 3415 m, 7 Aug. 1947, *J. T. Howell 23873* (CAS, RSA); Army Pass, 3659 m, 5 Aug. 1949, *J. T. Howell 26055* (CAS, DS, RSA, UC, US); W side of Morgan Pass, Rock Creek Lake basin, 3375 m, 16 July 1946, *J. T. Howell 22466* (CAS); Long Lake, Rock Creek Lake basin, 3230 m, 16 July 1946, *J. T. Howell 22450* (CAS); Mono Mesa, 3658 m, 26 July 1946, *J. T. Howell 22715* (DS, GH, US); unglaciated plateau just N of summit of Mt. Humphreys, 3925 m, 11 Aug. 1937, *C. W. Sharsmith 3119* (CAS, UC); Mono Co., NE slope of Sheep Mtn., White Mtns., 10 Aug. 1963, *R. M. Lloyd 3262* (CAS, UC); bottom of cirque heading N of fork of Perry Aiken Creek, 1.1 mi. E of White Mtn. peak, 3502 m, 25 July 1987, *J. D. Morefield & T. S. Ross 4698* (RSA); upper subalpine slopes of Chiatovich Flats, head of Cabin Creek, 3535 m, 31 July 1982, *D. W. Taylor 8073* (UC [terminal spikes atypical ♀/♂, ♂/♀, or ♂]); 1 mi. S of Barcroft Lab, 3658 m, 12 Aug. 1969, *S. N. Zufelt & R. K. Gierisch 79* (CAS); Dana Plateau, Mt. Dana, 15 July 1937, *C. W. Sharsmith 2495* (CAS), 1 Sep. 1937, *C. W. Sharsmith 3516* (UC), 10 Aug. 1944, *J. T. Howell 20279* (CAS); 0.5 km SW of Frog Lakes, 3200 m, 18 Aug. 2010, *P. F. Zika 25373* (CAS, JEPS, MICH, OSC, V, WS, WTU); 1.5 km S of Finger Lake, 3590 m, 17 Aug. 2010, *P. F. Zika 25359* (ASC, DAV, HSC, RENO, WTU); ridge N of W Granite Lake, 3375 m, 17 Aug. 2010, *P. F. Zika 25353 & A. Colwell, D. W. Taylor* (CHSC, MONTU, NY, SD, UBC, UCR, WTU); Tulare Co., John Muir Trail W of Center Peak, 3200 m, 30 July 1948, *J. T. Howell 25206* (RSA); Bubbs Creek Canyon, 3140 m, 26 July 1948, *J. T. Howell 25024* (CAS, RSA); near Primrose Lake, 3444 m, 24 July 1949, *J. T. Howell 25684* (CAS), *25691* (US); near tarn E of Farewell Gap, 3353 m, 20 July 1951, *J. T. Howell 27037* (CAS, US); Crabtree Creek, 3353 m, 21 July 1954, *P. H. Raven 7501* (CAS); Tuolumne Co., tarn at E end of Upper Gaylor Lake, NW of Gaylor Peak, Yosemite Natl. Park, 3220 m, 17 Aug. 2010, *P. F. Zika 25351 & A. Colwell, D. W. Taylor* (UC, WTU, YM); bowl near Sierra Nevada crest, Skelton Plateau, 2 air km SSW of Spuller Lake, Yosemite Natl. Park, 3560 m, 17 Aug. 2010, *P. F. Zika 25355 & A. Colwell, D. W. Taylor* (UC, WTU, YM).

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